

ITCS 314/312: Automata and Formal Languages

Exam 1, First semester 2014/2015, Form: A

Name: KEY
 Student Number: _____
 Section: _____

Section 1. (1 point each)

Mark the following statements with **True** if they are true and **False** otherwise.

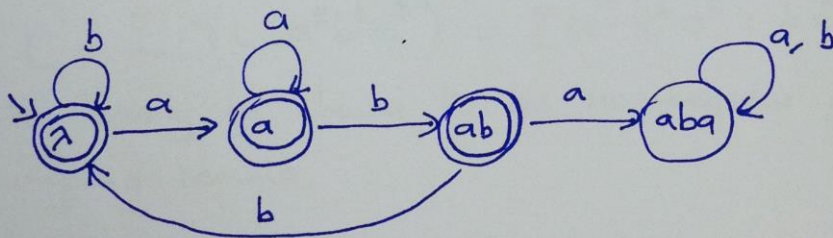
- False There exists a language L where $\overline{L^*} = (\overline{L})^*$. D
- False Nondeterminism is useless since every NFA can be represented by an equivalent ~~N~~FFA.
- True The grammar $S \rightarrow aS|aaS|aaaS|A; A \rightarrow a|b$ is a regular grammar.
- True Every finite language can be generated by a left-linear grammar.
- True The following grammar $S \rightarrow aaS|Sbb|b$ represents the language $L = \{a^{2n}b^{2n+1} : n \geq 0\}$.
- True The language $L = \{w \in \{a, b\}^+ : |w| \bmod 45 = 0\}$ can be generated using a regular expression.
- True The language $L = \{w \in \{a, b\}^* : w \text{ has at least 3 } a\text{'s and an even number of } b\text{'s}\}$ is regular.
- False The regular expression $(aa)^* + (bb)^*$ generates the language $\{a^n b^m : n + m \text{ is even}\}$.
- True Given two regular languages L_1 and L_2 , the language $L_1 - (L_2 \cap L_1)^*$ is also regular.
- False The language palindrome (where each word can be read left to right or right to left the same) over the alphabet $\{a, b\}$ is regular.

Section 2. (5 points each)

1. Consider the following language

$$L = \{w \in \{a, b\}^* : w \text{ does not contain the substring } aba\}.$$

Show that L is a regular language.



This is a DFA that accepts L . Hence L is regular.

2. Find a regular expression for the language

$$L = \{w \in \{a, b\}^* : \text{every occurrence of } a \text{ is followed by at least two } b\text{'s}\}.$$

$$r = (abb^* + b)^*$$

3. If the following language is regular show that it is regular, otherwise prove that it is not regular.

$$L = \{a^n b^l c^k : k \neq n + l\}.$$

$L_1 = \overline{L} \cap L(a^*b^*c^*) = \{a^n b^l c^k : k = n + l\}$ which can easily be shown to be non-regular using the pumping lemma.

Next, use the contrapositive

if $L_1 \cap L_2$ is not regular then L_1 is not regular or L_2 is not regular.

Since $L(a^*b^*c^*)$ is regular, then \overline{L} is not regular.

Next, use the fact that

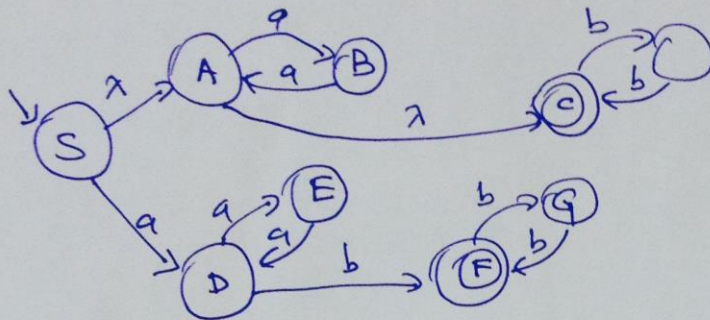
if \overline{L} is not regular then L is not regular

to conclude that

L is not regular.

4. Construct a regular grammar for the following language:

$$L = \{a^n b^m : n + m \text{ is even}\}.$$



Next copy the moves into a right-linear grammar

$S \rightarrow A$
 $A \rightarrow aB$
 $B \rightarrow aA$
 $A \rightarrow C$
 $C \rightarrow bbC \mid \lambda$
 $S \rightarrow aD$
 $D \rightarrow aaD \mid bF$
 $F \rightarrow bbF \mid \lambda$

5. Convert the following NFA to a DFA.

